building materials, and investigated the effects of several earthquakes upon tall chimneys. Dr. B. Koto has handed to the committee twenty-two papers on geological subjects connected with seismology and volcanology. Dr. H. Nagaoka gives a paper of intense interest to all physicists on the determination of the elastic constants of rocks; whilst the well-known professor of seismology, Dr. F. Ōmori, contributes six papers, each of importance to seismologists, and for the most part indispensable to those who have to construct in earthquake countries.

Volumes v. and vi., which contain the analysis of the diagrams of 246 earthquakes observed in Tokyo between July 1898 and December 1899, are entirely from Dr. Omori's pen, and although we may not concur in all the results he sets before us, seismologists in general must thank him for the vast quantity of material which he has brought together and systematised for their consideration. For the earthquakes which originated at great distances from Japan, so far as possible each seismogram has been divided into parts which succeed each other in the following order: "First preliminary tremors," in which waves of 4 seconds period are superimposed upon those of 8 seconds; "second preliminary tremors," with periods of 8 seconds, and accompanied by undulations of 14, 25 and 66 seconds period; "the principal portion" of the earthquake, which is divided into three phases also dependent on period, and finally the "end portion," in which period is fairly regular. The regularity of the terminal vibrations may, as Dr. Ōmori remarks, be explained on the assumption that different portions of the earth's crust have particular periods of free oscillation. The discussion of these various types of earthquake motion is based on the assumption that the waves recorded are *horizontal movements and not tiltings of the ground.*

One observation which led Dr. Ōmori to take this view is that he has obtained seismograms which show that the amplitude of motion depends upon the multiplication ratio of the writing pointers attached to his pendulums, and not upon their sensibility to tilting. In addition to this he points out that if the undulations recorded were due to tilting, then the accelerations involved are such that our sense of feeling should be affected, which is not the case. Since Dr. A. Cancani, in 1893, drew attention to the fact that calculations based on a knowledge of the period, velocity and maximum tiltings of these unfelt undulations led to the conclusion that the inhabitants of the world were raised and lowered two or three feet hundreds of times per annum and had never observed the same, seismologists have regarded with suspicion the elements in the calculations leading to these results. Notwithstanding this, when we have so very much evidence of turbulent wave-like motion in and around epifocal districts, and evidence of repeated tiltings at distances of several hundred miles from the same, it is difficult to escape from the conclusion that similar but slower period movements may be propagated, like a swell upon an ocean, to very distant places, and seismographic pendulums be caused to swing.

Dr. Ōmori has certainly thrown new light upon the nature of the large waves, and it does not seem improbable that investigations carried out upon other lines may, if not completely at least partially, confirm his views.

A more debatable subject touched upon relates to paths followed by earthquake waves through the earth's crust. Because the velocity of the quick period phase of the large waves nearly equals that of local earthquakes, it is assumed that the former, like the latter, are propagated along the surface of the earth's crust, whilst waves which precede them travel at some small depth in the same. Inasmuch as the first preliminary tremors have, at a given station, a duration proportional to the arcual distance of this station from the origin of the earthquake, Dr. Omori thinks it likely that they are transmitted along paths nearly parallel to the surface of the earth, and at a probably constant depth.

Several sections in vol. v. refer to subjects which are not seismic, although they are of great interest to those engaged in certain branches of physical research. For example, references are made to the effect of slight loads upon masonry structures, whilst "oscillations of the ground," whose origin is not seismic, are discussed at some length. That we have for years past been acquainted with movements of pendulums and balances not proper to those of the instruments themselves, which may continue for hours or days, suggests the question whether we are not here being re-introduced to an old enemy in a new dress. Are these movements due to those of the ground or to local movements in the atmosphere? Can Dr. Omori assure us that similar instruments, placed in different rooms or under conditions which are different with regard to temperature and ventilation, behave similarly? If this be the case, then the distinction which has so frequently been drawn between "pulsations" and "air tremors" will be more clearly established. In a stable at Shide "air tremor" effects are, at certain seasons, frequent, whilst at times pendulums with a 15 seconds period will yield diagrams showing that they have been moving regularly with a period of two or three minutes. In an adjoining coach-house these movements are absent, and similar phenomena are common to Tokyo and other places.

What has here been said indicates the nature of the work now in progress in Dai Nippon, a complete account of which is to be found in thirty-two well-illustrated quarto volumes, which, unfortunately for Europeans, are written in Chinese characters. These volumes are with but little doubt one of the greatest store-houses extant of information relating to practical seismology, and as such it is to be hoped that an abstract, or at least a table, of their contents may be published in a European language.

As an example of their value we may select vols. xxii. and xxv., referring to an earthquake which in 1897 devastated North-Eastern India, and cost British investors and taxpayers several millions sterling. The first of these is by Dr. T. Nakamura, an architect, and it contrasts those forms of structure which withstood the effects of the earthquake with those which failed. The second, which treats of railway and bridge construction, is by Mr. T. Koyama, a railway engineer. These gentlemen are two out of four who were sent to India by their Government for the purpose of increasing their own extensive knowledge as to forms of structures most suitable for earthquake countries. On this occasion, as in others, special men were selected for special work, with the result that, not only has Japan profited by disasters of this character, but she has become a teacher of nations in practical seismology, and we, amongst others, may offer her thanks and congratulations on her efforts to save life and property.

J. MILNE.

THE EYE IN THE RECENTLY DISCOVERED CAVE SALAMANDER OF TEXAS.[1]

THE tailed Batrachia have during recent years attained an increased importance zoologically, by appreciation of the fact that in respect to many features in which their living representatives present a simplification of organisation they are retrograde. While but one of them possesses a complete maxillo-jugal arch, none are pentadactyle in both fore- and hind-limbs; and the unexpected has been reached, in the discovery that there

[1] "The Eyes of the Blind Vertebrates of North America," by C. H. Eigenmann (*Trans.* Americ. Microsc. Soc., vol. xxi. pp. 49-60), by C. H. Eigenmann and W. A. Denny (*Biological Bulletin*, Boston, U.S.A., vol. ii. pp. 33-40)

are no fewer than ten species of six genera which are lungless, and that in some of these respiration is largely buccal or pharyngeal, and may even, in all probability, involve the tips of the toes, as in *Autodax* and species of other known genera.

Conspicuous among recently discovered species are three of American origin which are cave-dwellers. Of these, one (a *Spelerpes*), occurring in the Mississippi Vale, has nondegenerate eyes; another (*Typhlotriton*), more restricted in the same region, has eyes which during growth undergo a recognisable degeneration. The third (*Typhlomolge*), discovered in 1896 in the underground waters of Texas, where it was obtained from an artesian well, said by our authors to be now thrown up at the rate of about fifty a year, is quite blind, possessed of functionless eyes. It is with the paper upon this genus that we have chiefly here to deal. The animal itself is of especial interest, as furnishing the much-desired American counterpart for the European *Proteus* long known. It differs from this, however, in being shorter bodied and longer limbed—so much so that the limbs appear by attenuation to have become converted into tactile organs—and the discovery that the eye is destitute of lens, rods and cones, and eye-muscles (which is the most interesting fact announced in these papers) is thus intensely significant, as it presents us among the Batrachia with a condition recalling that of the famous blind locust of the New Zealand caves, in which, under the functional atrophy of the eye, the antennæ have similarly become elongated and more important.

The second paper deals with the eye of the Mississippi cave salamander *Typhlotriton*, which, while "detecting its food by the sense of touch," shows only the first stages of that degeneration of the eye and its associated organs occurring in the Typhlomolge type. Both papers are illustrated, though very poorly, and they do not in this respect compare with previously published works on other blind animals which might be cited. Moreover, there is in the first paper an inexplicable error, for the senior author, stating that "the eye of Typhlotriton will be dealt with in another place" (*i.e.* the second paper herein quoted), continues erroneously to use this generic name in describing the Typhlomolge eye.

Typhlomolge is in every respect a most remarkable creature, as examination of the example preserved in our National Museum at South Kensington will show. The description of its eye, coming to us at a time when there has just been found (in the French Congo area) a frog in which the terminal phalanges of four of the hinder digits, perforating the overlying integument as do the ribs of the long-known Pleurodile Newt, project, freely and exposed, as sharply recurved claws. All this brings forcibly before us the lesson that in morphologically specialised forms of life, such as we are too apt to pooh-pooh, there are to be found facts which, on the whole, are among the most trustworthy, in enabling us to gauge the limits of nature's operations. Truly has Weismann remarked (as pointed out by the senior author in his 1899 Woods' Holl Lecture on "The Blind Fishes") that "an investigation into the history of degenerate forms often teaches us more of the causes of change in organic nature than can be learned by the study of the progressive ones.

G. B. H.

THE COMMERCIAL USES OF PEAT.

THE difficulty in obtaining coal for industrial purposes, and the high price that has had to be paid for it recently, especially where works are situated at long distances away from the mines, has led to more attention being paid to the use of peat for fuel. In the "Notes" of May 31, 1900 (vol. lxii. p. 108), a short description was given of the uses to which peat was being applied in Austria in the manufacture of textile fabrics. In a recent number of the *Engineer* (February 8, 1901) an account was also given of the peat fuel industry in Sweden. It is said that there is hardly any question of the day so prominent in that country as the use of peat fuel as a substitute for coal. The Government, recognising the importance of this matter, has appointed a Crown Peat Engineer, at a salary of 500*l.* a year, to survey the principal Crown peat bogs and to report upon the quality and suitability of the peat for use as fuel in locomotive engines. At several of the large works in Sweden peat is now used for generating steam. At the great Yungtell Metal Works and the Motala Shipbuilding Works, it is also used in generating furnace gases, the fuel being prepared by specially constructed works. At the former establishment, engines of 230 horse-power are supplied with steam generated by this fuel. In the province of Smaland a syndicate has recently purchased the peat bogs, from which it is estimated that a million tons of fuel will be produced in a year. At the Karpalund sugar refinery peat is now solely used for the nine boilers in use there of 100 horse-power each; the fuel being first converted into gas in generators in front of the boilers. This establishment has purchased an adjacent bog containing sufficient peat to supply the works for twenty years. The bog is connected with the factory by a Decauville railway. The furnaces were formerly fed by coal obtained from England, and a very great saving has been effected, the peat fuel costing less than half that of coal. On several of the railways peat is being tried as fuel for the locomotives with every promise of permanent success. There are several different kinds of machines for making this fuel. The process something resembles brick-making. The turf is cut from the bog either by manual labour or machinery, and stacked in summer to be air-dried, any remaining moisture being removed in heated drums or by centrifugals, and the peat is then compressed into briquettes. It is claimed that one ton of dried peat from the best class of bogs is equal to half a ton of English coal.

The largest area of peat in England is to be found in the Fen district, where it covers 600 square miles and the depth varies from 2 to 10 feet in thickness, and at Whittlesea Mere as much as 18 feet. Nearly the whole of the peat in the Fenland has been drained and is now cultivated.[1] In a few places in the Fens it is sun-dried and used for fuel. In the form of powder and mixed with carbolic acid it is also extensively used as a deodorant for earth closets and similar purposes, works for this purpose being established in Cambridgeshire.

There are also large deposits in the East Riding of Yorkshire along the valleys of the Trent and Ouse, Hatfield Chase covering 12,000 acres, where a manufactory has been for some years in existence for drying and preparing the peat for litter for stables and cow-houses. Its antiseptic properties make this litter very valuable, especially in large towns where straw is difficult to obtain. There are also large areas of peat in other parts of the country, as at Chatmoss in Lancashire and on Dartmoor.

In Ireland, the peat bogs cover about 5000 square miles, or about one-seventh of the whole country; some of the bogs are 43 feet deep, the average thickness being 26 feet. Occasionally, owing to an excess of water, the peat overflows the basin in which it is contained and flows over the cultivated land. Thus a few years ago the bog near Tullamore overflowed and covered nearly three square miles of land. Sun-dried peat is used in Ireland to a considerable extent for fuel. Some attempt has been made to work it for commercial purposes. The Irish Amelioration Society some years ago encouraged the conversion of it into charcoal, but the process was

1 "The History of the Fens of South Lincolnshire." (London: Chapman and Hall.)